

## WHAT IS CLAIMED IS:

1. A liquid crystal display device of a multi-domain vertical-alignment mode, comprising:
- a driving substrate having a pixel electrode;
  - a counter substrate opposing said driving substrate and having a counter electrode; and
  - a liquid crystal sandwiched between said substrates, wherein molecules of said liquid crystal are aligned nearly perpendicularly to said substrates when no electric field is produced, and are aligned nearly horizontally by the application of a predetermined voltage,
- wherein said counter substrate has an alignment center portion for orienting said molecules of said liquid crystal in all directions centered on a certain point when the voltage is applied, and
- wherein the area of said alignment center portion of said counter substrate is set to be less than or equal to 5% of the area of one pixel.

2. A liquid crystal display device according to Claim 1, wherein said alignment center portion is a protuberance or an alignment disturbing surface.

3. A liquid crystal display device according to Claim 2, wherein the base area of said protuberance is within the range of 50  $\mu\text{m}^2$  to 225  $\mu\text{m}^2$ .

4. A liquid crystal display device according to Claim 2, wherein the base area of said alignment disturbing surface is less than or equal to 225  $\mu\text{m}^2$ .

5. A liquid crystal display device according to Claim 1, wherein said pixel electrode of said driving substrate or said counter substrate is provided with a slit, a cut, or a hole for making multi-domain alignment of said liquid crystal nearly vertically or horizontally symmetric.

6. A liquid crystal display device according to Claim 1, wherein a chiral material is added to said liquid crystal.

7. A liquid crystal display device according to Claim 6, wherein the chiral pitch  $L$  and the cell gap  $d$  of said liquid crystal have a relation  $2.5 < L/d < 5.5$ .

8. A liquid crystal display device according to Claim 1, wherein said liquid crystal display device is of an active matrix type.

9. A liquid crystal display device according to Claim 8, wherein a pixel pitch is less than or equal to 70  $\mu\text{m}$ .

10. A liquid crystal display device according to Claim 1, wherein a retardation film for compensating the viewing angle is placed between said driving substrate or said counter substrate, and a polarizer on the outside of said driving substrate or said counter substrate, and the following conditions are satisfied:

$$0.7 < \frac{N_x - N_y}{N_z} < 1.3$$

$$(N_x - N_y) \cdot d_{\text{film}} < 100 \text{ nm}$$

where  $N_x$  and  $N_y$  represent the refractive indices of said retardation film in the in-plane directions,  $N_z$  represents the refractive index of said retardation film in the thickness direction,  $d_{\text{film}}$  represents the thickness of said retardation film,  $n$  represents the refractive index anisotropy of said liquid crystal, and  $d_{\text{LC}}$  represents the cell gap.

11. A liquid crystal display device according to Claim 2, wherein a retardation film for compensating the viewing angle is placed between said driving substrate or said counter substrate, and a polarizer on the outside of said driving substrate or said counter substrate, and the following conditions are satisfied:

$$0.7 < \gamma < 1.3$$

$$(N_x - N_y) (d_{\text{film}} < 100 \text{ nm})$$

where  $N_x$  and  $N_y$  represent the refractive indices of said retardation film in the in-plane directions,  $N_z$  represents the refractive index of said retardation film in the thickness direction,  $d_{\text{film}}$  represents the thickness of said retardation film,  $\gamma$  represents the refractive index anisotropy of said liquid crystal, and  $d_{\text{LC}}$  represents the cell gap.

12. A liquid crystal display device according to Claim 3, wherein a retardation film for compensating the viewing angle is placed between said driving substrate or said counter substrate, and a polarizer on the outside of said driving substrate or said counter substrate, and the following conditions are satisfied:

$$0.7 < \gamma < 1.3$$

$$(N_x - N_y) (d_{\text{film}} < 100 \text{ nm})$$

where  $N_x$  and  $N_y$  represent the refractive indices of said retardation film in the in-plane directions,  $N_z$  represents

the refractive index of said retardation film in the thickness direction,  $d_{\text{film}}$  represents the thickness of said retardation film,  $(n$  represents the refractive index anisotropy of said liquid crystal, and  $d_{\text{LC}}$  represents the cell gap.

13. A liquid crystal display device according to Claim 4, wherein a retardation film for compensating the viewing angle is placed between said driving substrate or said counter substrate, and a polarizer on the outside of said driving substrate or said counter substrate, and the following conditions are satisfied:

$$0.7 < < 1.3$$

$$(N_x - N_y) (d_{\text{film}} < 100 \text{ nm})$$

where  $N_x$  and  $N_y$  represent the refractive indices of said retardation film in the in-plane directions,  $N_z$  represents the refractive index of said retardation film in the thickness direction,  $d_{\text{film}}$  represents the thickness of said retardation film,  $(n$  represents the refractive index anisotropy of said liquid crystal, and  $d_{\text{LC}}$  represents the cell gap.

14. A liquid crystal display device according to Claim 5, wherein a retardation film for compensating the viewing angle is placed between said driving substrate or said counter substrate, and a polarizer on the outside of said

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driving substrate or said counter substrate, and the following conditions are satisfied:

$$0.7 < \gamma < 1.3$$

$$(N_x - N_y) (d_{\text{film}} < 100 \text{ nm})$$

where  $N_x$  and  $N_y$  represent the refractive indices of said retardation film in the in-plane directions,  $N_z$  represents the refractive index of said retardation film in the thickness direction,  $d_{\text{film}}$  represents the thickness of said retardation film,  $n$  represents the refractive index anisotropy of said liquid crystal, and  $d_{\text{LC}}$  represents the cell gap.

15. A liquid crystal display device according to Claim 6, wherein a retardation film for compensating the viewing angle is placed between said driving substrate or said counter substrate, and a polarizer on the outside of said driving substrate or said counter substrate, and the following conditions are satisfied:

$$0.7 < \gamma < 1.3$$

$$(N_x - N_y) (d_{\text{film}} < 100 \text{ nm})$$

where  $N_x$  and  $N_y$  represent the refractive indices of said retardation film in the in-plane directions,  $N_z$  represents the refractive index of said retardation film in the thickness direction,  $d_{\text{film}}$  represents the thickness of said retardation film,  $n$  represents the refractive index

anisotropy of said liquid crystal, and dLC represents the cell gap.

16. A liquid crystal display device according to Claim 7, wherein a retardation film for compensating the viewing angle is placed between said driving substrate or said counter substrate, and a polarizer on the outside of said driving substrate or said counter substrate, and the following conditions are satisfied:

$$0.7 < \gamma < 1.3$$

$$(N_x - N_y) (d_{\text{film}} < 100 \text{ nm})$$

where  $N_x$  and  $N_y$  represent the refractive indices of said retardation film in the in-plane directions,  $N_z$  represents the refractive index of said retardation film in the thickness direction,  $d_{\text{film}}$  represents the thickness of said retardation film,  $\gamma$  represents the refractive index anisotropy of said liquid crystal, and dLC represents the cell gap.

17. A liquid crystal display device according to Claim 8, wherein a retardation film for compensating the viewing angle is placed between said driving substrate or said counter substrate, and a polarizer on the outside of said

driving substrate or said counter substrate, and the following conditions are satisfied:

$$0.7 < \Delta n < 1.3$$

$$(N_x - N_y) (d_{\text{film}} < 100 \text{ nm})$$

where  $N_x$  and  $N_y$  represent the refractive indices of said retardation film in the in-plane directions,  $N_z$  represents the refractive index in the thickness direction,  $d_{\text{film}}$  represents the thickness,  $\Delta n$  represents the refractive index anisotropy of said liquid crystal, and  $d_{\text{LC}}$  represents the cell gap.

18. A liquid crystal display device according to Claim 9, wherein a retardation film for compensating the viewing angle is placed between said driving substrate or said counter substrate, and a polarizer on the outside of said driving substrate or said counter substrate, and the following conditions are satisfied:

$$0.7 < \Delta n < 1.3$$

$$(N_x - N_y) (d_{\text{film}} < 100 \text{ nm})$$

where  $N_x$  and  $N_y$  represent the refractive indices of said retardation film in the in-plane directions,  $N_z$  represents the refractive index of said retardation film in the thickness direction,  $d_{\text{film}}$  represents the thickness of said retardation film,  $\Delta n$  represents the refractive index anisotropy of said liquid crystal, and  $d_{\text{LC}}$  represents the cell gap.



19. A production method for a liquid crystal display device of a multi-domain vertical-alignment mode in which a driving substrate having a pixel electrode and a counter substrate having a counter electrode are opposed to each other, a liquid crystal is sandwiched between said substrates, and molecules of said liquid crystal are aligned nearly perpendicularly to said substrates when no electric field is produced, and are aligned nearly horizontally by the application of a predetermined voltage,

wherein said counter substrate has an alignment center portion for orienting said molecules of said liquid crystal in all directions centered on a certain point when the voltage is applied, and

wherein the area of said alignment center portion of said counter substrate is set to be less than or equal to 5% of the area of one pixel.

20. A production method for a liquid crystal display device according to Claim 19, wherein a protuberance is formed as said alignment center portion by applying a photosensitive resin onto said counter substrate, and patterning said photosensitive resin.

21. A production method for a liquid crystal display device according to Claim 20, wherein the base area of said protuberance is within the range of 50 (m<sup>2</sup> to 225 (m<sup>2</sup>.

22. A production method for a liquid crystal display device according to Claim 19, wherein an alignment disturbing surface is formed as said alignment center portion by applying different types of alignment films, or by applying UV light, polarized light, or an ion beam.

23. A production method for a liquid crystal display device according to Claim 19, wherein said driving substrate or said counter substrate is provided with a slit, a cut, or a hole for making multi-domain alignment of said liquid crystal nearly vertically or horizontally symmetric.

24. A production method for a liquid crystal display device according to Claim 19, wherein a chiral material is added to said liquid crystal.

25. A production method for a liquid crystal display device according to Claim 24, wherein the chiral pitch L and the cell gap d of said liquid crystal have a relation  $2.5 < L/d < 5.5$ .

26. A production method for a liquid crystal display device according to Claim 19, wherein a TFT substrate is used as said driving substrate.

27. A production method for a liquid crystal display device according to Claim 26, wherein a pixel pitch is less than or equal to 70  $\mu\text{m}$ .

28. A production method for a liquid crystal display device according to Claim 19, wherein a retardation film for compensating the viewing angle is placed between said driving substrate or said counter substrate, and a polarizer on the outside of said driving substrate or said counter substrate, and the following conditions are satisfied:

$$0.7 < \gamma < 1.3$$

$$(N_x - N_y) \cdot d_{\text{film}} < 100 \text{ nm}$$

where  $N_x$  and  $N_y$  represent the refractive indices of said retardation film in the in-plane directions,  $N_z$  represents the refractive index of said retardation film in the thickness direction,  $d_{\text{film}}$  represents the thickness of said retardation film,  $n$  represents the refractive index anisotropy of said liquid crystal, and  $d_{\text{LC}}$  represents the cell gap.

29. A production method for a liquid crystal display device according to Claim 20, wherein a retardation film for compensating the viewing angle is placed between said driving substrate or said counter substrate, and a polarizer on the outside of said driving substrate or said counter substrate, and the following conditions are satisfied:

$$0.7 < \Delta n < 1.3$$

$$(N_x - N_y) \cdot d_{\text{film}} < 100 \text{ nm}$$

where  $N_x$  and  $N_y$  represent the refractive indices of said retardation film in the in-plane directions,  $N_z$  represents the refractive index of said retardation film in the thickness direction,  $d_{\text{film}}$  represents the thickness of said retardation film,  $\Delta n$  represents the refractive index anisotropy of said liquid crystal, and  $d_{\text{LC}}$  represents the cell gap.

30. A production method for a liquid crystal display device according to Claim 21, wherein a retardation film for compensating the viewing angle is placed between said driving substrate or said counter substrate, and a polarizer on the outside of said driving substrate or said counter substrate, and the following conditions are satisfied:

$$0.7 < \Delta n < 1.3$$

$$(N_x - N_y) \cdot d_{\text{film}} < 100 \text{ nm}$$

where  $N_x$  and  $N_y$  represent the refractive indices of said retardation film in the in-plane directions,  $N_z$  represents

the refractive index of said retardation film in the thickness direction,  $d_{\text{film}}$  represents the thickness of said retardation film,  $(n$  represents the refractive index anisotropy of said liquid crystal, and  $d_{\text{LC}}$  represents the cell gap.

31. A production method for a liquid crystal display device according to Claim 22, wherein a retardation film for compensating the viewing angle is placed between said driving substrate or said counter substrate, and a polarizer on the outside of said driving substrate or said counter substrate, and the following conditions are satisfied:

$$0.7 < < 1.3$$

$$(N_x - N_y) (d_{\text{film}} < 100 \text{ nm}$$

where  $N_x$  and  $N_y$  represent the refractive indices of said retardation film in the in-plane directions,  $N_z$  represents the refractive index of said retardation film in the thickness direction,  $d_{\text{film}}$  represents the thickness of said retardation film,  $(n$  represents the refractive index anisotropy of said liquid crystal, and  $d_{\text{LC}}$  represents the cell gap.

32. A production method for a liquid crystal display device according to Claim 23, wherein a retardation film for compensating the viewing angle is placed between said driving substrate or said counter substrate, and a polarizer on the

outside of said driving substrate or said counter substrate, and the following conditions are satisfied:

$$0.7 < \gamma < 1.3$$

$$(N_x - N_y) (d_{\text{film}} < 100 \text{ nm})$$

where  $N_x$  and  $N_y$  represent the refractive indices of said retardation film in the in-plane directions,  $N_z$  represents the refractive index of said retardation film in the thickness direction,  $d_{\text{film}}$  represents the thickness of said retardation film,  $\gamma$  represents the refractive index anisotropy of said liquid crystal, and  $d_{\text{LC}}$  represents the cell gap.

33. A production method for a liquid crystal display device according to Claim 24, wherein a retardation film for compensating the viewing angle is placed between said driving substrate or said counter substrate, and a polarizer on the outside of said driving substrate or said counter substrate, and the following conditions are satisfied:

$$0.7 < \gamma < 1.3$$

$$(N_x - N_y) (d_{\text{film}} < 100 \text{ nm})$$

where  $N_x$  and  $N_y$  represent the refractive indices of said retardation film in the in-plane directions,  $N_z$  represents the refractive index of said retardation film in the thickness direction,  $d_{\text{film}}$  represents the thickness of said retardation film,  $\gamma$  represents the refractive index

anisotropy of said liquid crystal, and dLC represents the cell gap.

34. A production method for a liquid crystal display device according to Claim 25, wherein a retardation film for compensating the viewing angle is placed between said driving substrate or said counter substrate, and a polarizer on the outside of said driving substrate or said counter substrate, and the following conditions are satisfied:

$$0.7 < \gamma < 1.3$$

$$(N_x - N_y) (d_{\text{film}} < 100 \text{ nm})$$

where  $N_x$  and  $N_y$  represent the refractive indices of said retardation film in the in-plane directions,  $N_z$  represents the refractive index of said retardation film in the thickness direction,  $d_{\text{film}}$  represents the thickness of said retardation film,  $\gamma$  represents the refractive index anisotropy of said liquid crystal, and dLC represents the cell gap.

35. A production method for a liquid crystal display device according to Claim 26, wherein a retardation film for compensating the viewing angle is placed between said driving substrate or said counter substrate, and a polarizer on the outside of said driving substrate or said counter

substrate, and the following conditions are satisfied:

$$0.7 < < 1.3$$

$$(N_x - N_y) (d_{\text{film}} < 100 \text{ nm})$$

where  $N_x$  and  $N_y$  represent the refractive indices of said retardation film in the in-plane directions,  $N_z$  represents the refractive index of said retardation film in the thickness direction,  $d_{\text{film}}$  represents the thickness of said retardation film,  $n$  represents the refractive index anisotropy of said liquid crystal, and  $d_{\text{LC}}$  represents the cell gap.

36. A production method for a liquid crystal display device according to Claim 27, wherein a retardation film for compensating the viewing angle is placed between said driving substrate or said counter substrate, and a polarizer on the outside of said driving substrate or said counter substrate, and the following conditions are satisfied:

$$0.7 < < 1.3$$

$$(N_x - N_y) (d_{\text{film}} < 100 \text{ nm})$$

where  $N_x$  and  $N_y$  represent the refractive indices of said retardation film in the in-plane directions,  $N_z$  represents the refractive index of said retardation film in the thickness direction,  $d_{\text{film}}$  represents the thickness of said retardation film,  $n$  represents the refractive index anisotropy of said liquid crystal, and  $d_{\text{LC}}$  represents the cell gap.

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